

Building Scalable Wireless Networks

ATI-4 Campus Wireless Networking



Wireless in the Campus Network

| **Edge Access = Access For Users**

- | Connect users (laptops, desktops, phones, tablets) to the network, services and Internet

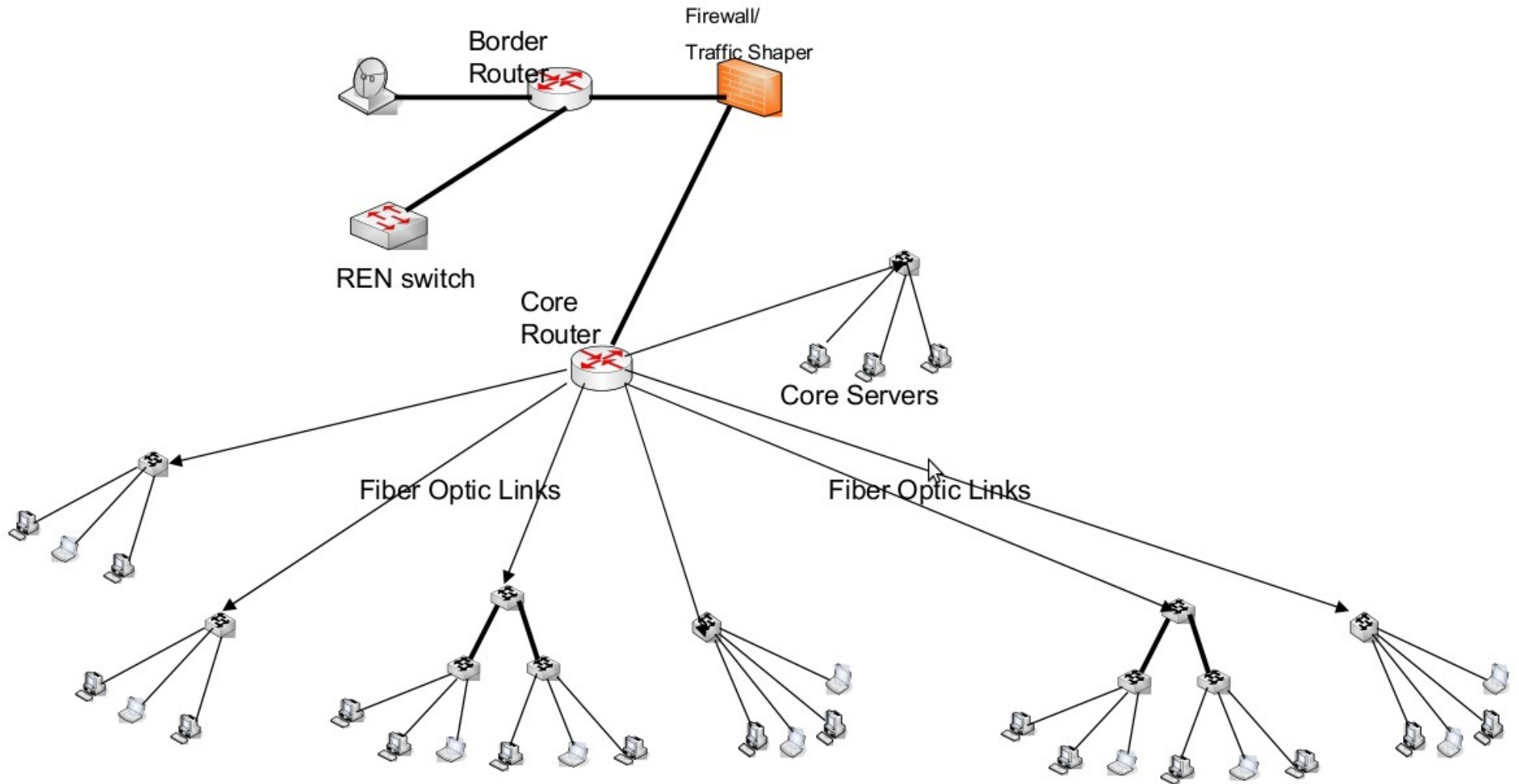
| **Infrastructure/Backbone**

- | Distance, terrain, or obstacles make fibre too hard?
Use wireless point-to-point links

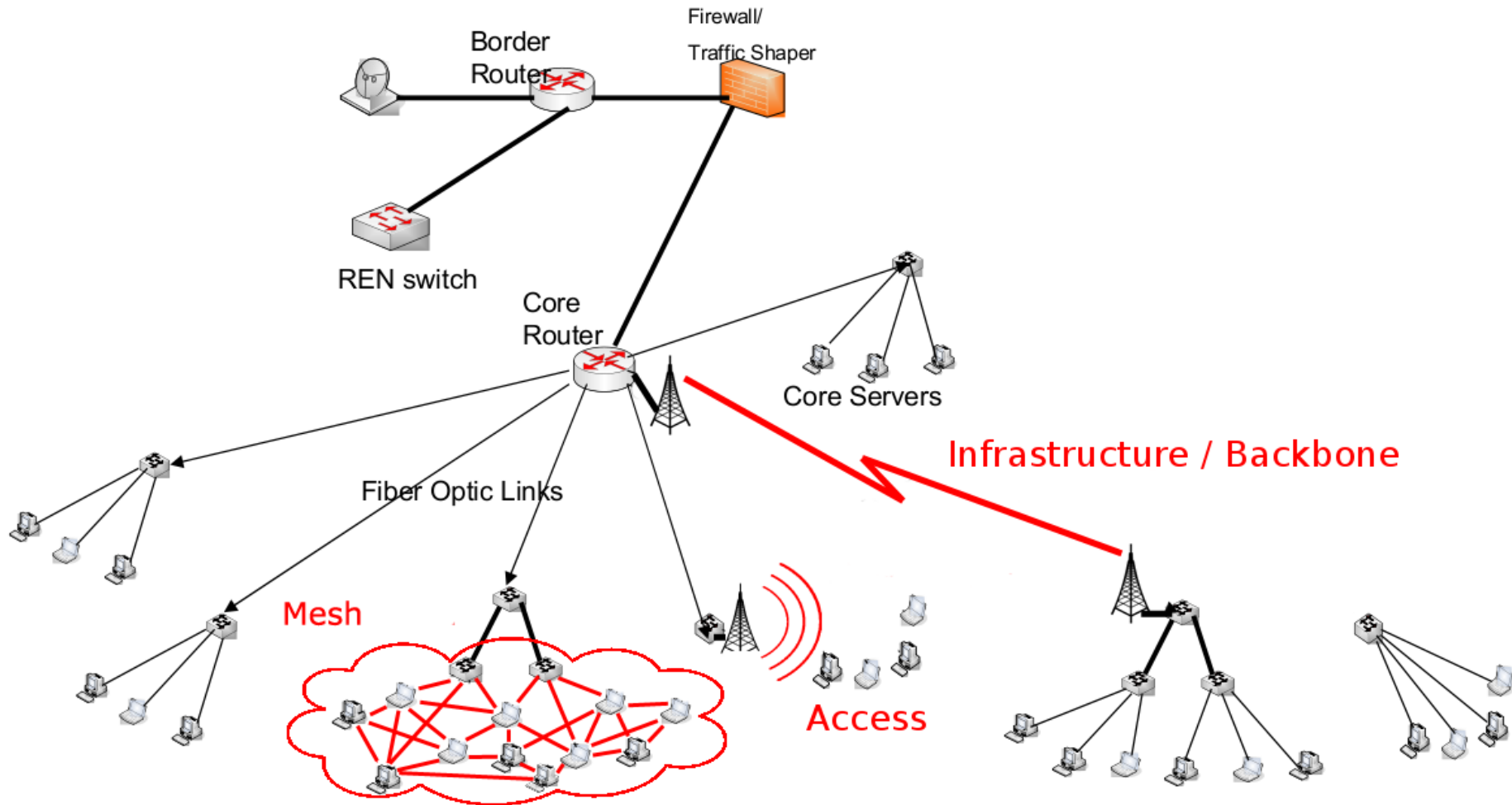
| **Mesh**

- | Where line of sight is difficult, mesh networks can act both as edge access and infrastructure

Wired Campus Networks



Wireless Campus Network



Best Practices

Wired & Wireless Networks Are Similar

- | Build structured, hierarchical networks
 - Build stars and trees, not chains
- | Route at the core, switch on the edge
- | Don't build huge flat networks – Subnet!
 - Plan the size of subnets

Separate Access & Core Networks

- | It is important to keep a strict line between access and core networks
- | Users should not see infrastructure
 - | Do not allow users to see management network
 - | Do not advertise SSIDs for backbone links
 - | Control access to 802.11 backbone links
 - | With security and by MAC address
- | Keep user traffic away from your infrastructure!

Wired / Wireless Differences

- | Physical location disconnected from network logic
 - A user on the library network might in fact be 10 miles away
- | Link quality no longer binary
 - | not “working” or “not working”, but something in-between
- | New parameters separate networks on Layer 1/2:
 - frequency, protocol, ssid, polarization, ...
- | Networks change over time
 - | Devices come and go
 - | Need to consider roaming
- | Clients difficult to control & numbers growing fast

Wireless Management Tools

Enterprise Wireless

- | Authentication & Access
- | Configuration Mgmt
- | Controllers & Roaming
- | Documentation
- | Network Management
- | Security
- | Survey Tools

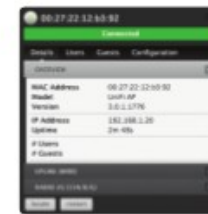
Wired/Wireless Access Point Each icon indicates the location of the Access Point on the map. Click and hold this icon to drag the Access Point to another location on the map. Click an Access Point icon to reveal additional options. Click a blank area of the map to hide the icons.

Note: Not all icons are shown here.



Lock Lock the selected Access Point to the current location on the map.

Details Display the Details screen so you can view and edit the Access Point configuration. You can also view the lists of connected users and guests. For more information, go to ["Access Point Details" on page 32](#).



Remove Remove the Access Point from its location on the map.

Show: Click any of the following options to display Access Point labels, details, wireless coverage, and topology on the map.



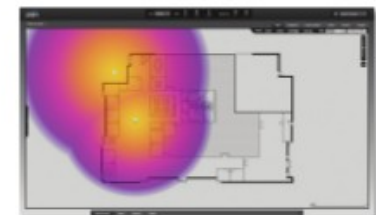
Labels Displays the name applied to the Access Point. Refer to *Atlas* under ["Configuration" on page 36](#) to change a name applied to an Access Point. If no custom label is applied, the Access Point's MAC address will be displayed.



Details Displays the Access Point name, MAC address, transmit/receive channel, number of users connected, and number of guests connected.



Coverage Displays a visual representation of the wireless range covered by the Access Point.



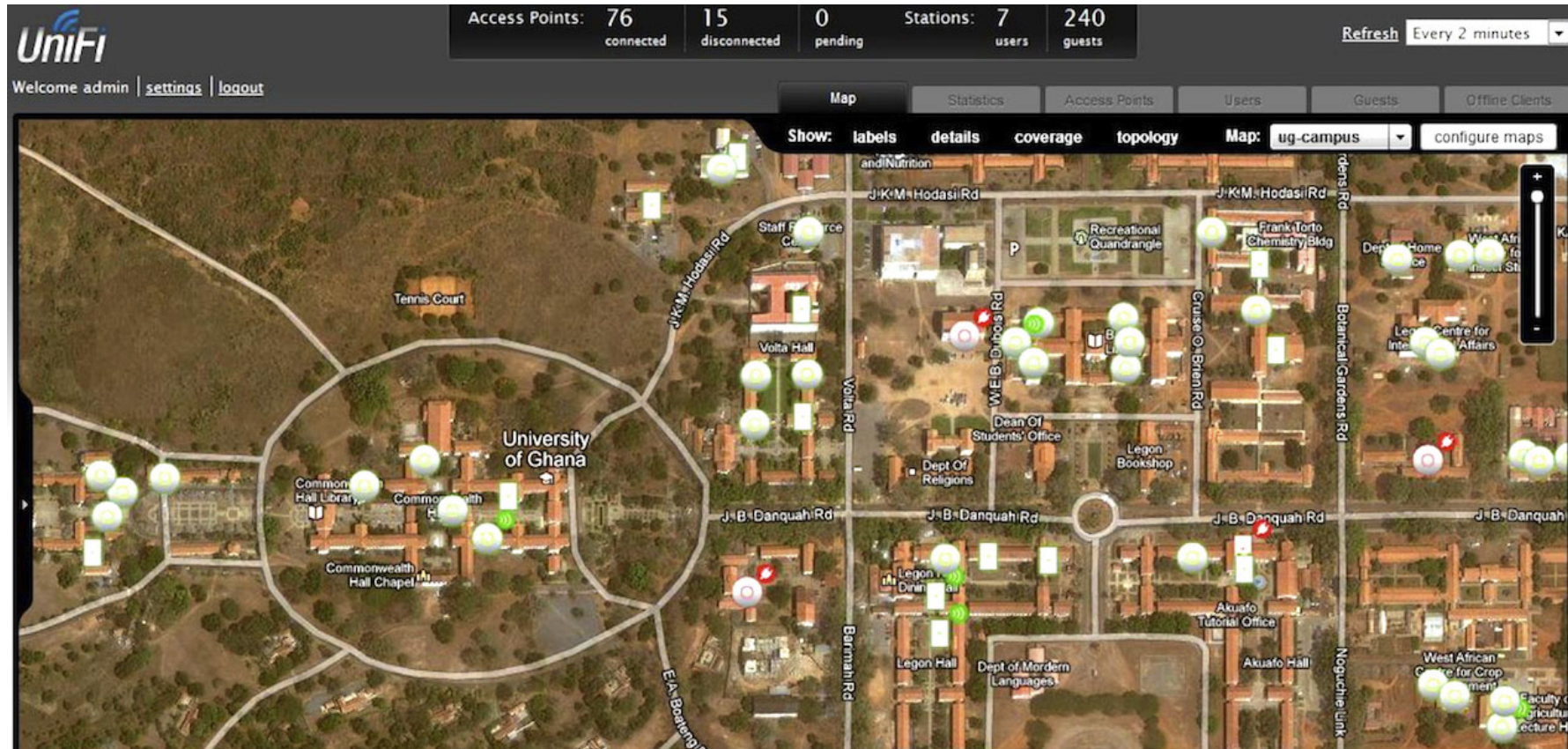
Wireless Network Planning

- | Required to solve new problems wireless brings
 - | Frequency monitoring & management
 - | Reach & Power planning: Link budgets, Antennas
 - | SSID planning: Names matter!
 - | Rogue activity monitoring and management
 - | Plan Subnet Sizes
 - | Tradeoff between roaming ease & network scalability

Essential Planning: Site Surveys

- | No matter what network you are building
 - | core infrastructure or edge access
 - | indoor or outdoor
 - | small or big
- | A site survey is mandatory
- | Results of the site survey are the basis for your technology and process decisions

Essential Planning: Site Surveys



Source: University of Ghana, Legon Campus

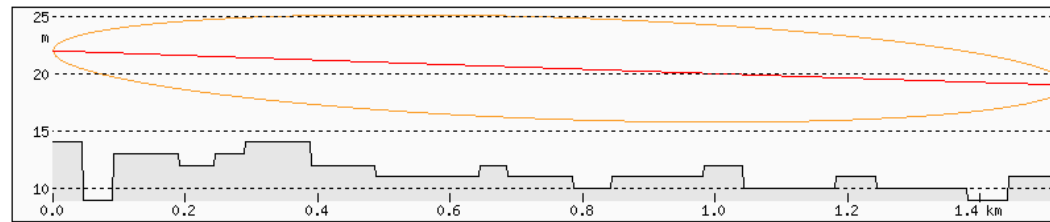
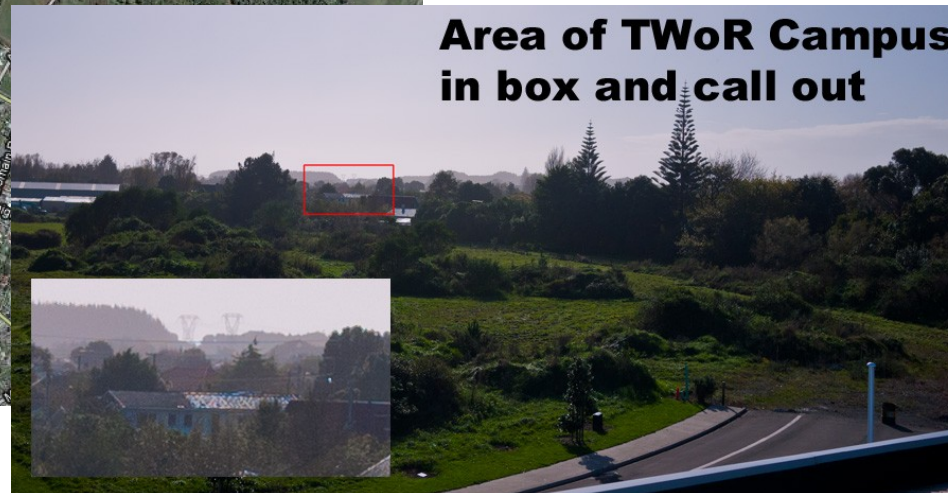
Essential Planning: Site Surveys

- | Spectrum analysis, wireless scan
 - | Check for existing services, conflicts, interference
- | Power and electricity conditions
- | Wired network conditions
- | Environmental conditions
- | Social / human factors: who are my neighbours?
 - | Networking is more than just pings
- | Everything should be documented!

Essential Planning: Site Surveys



Desktop Survey looked great
In-person found trees in path



Essential Planning: Site Surveys



600 mm antenna
facing Maupuia
incl. new mount

two 380 mm antennas
facing Kibirnie and
Rongotai

Detail of east side

Surveys Document

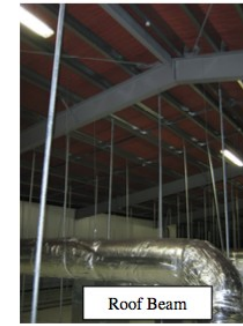
- Existing Infrastructure
- Proposed Infrastructure
- Cabling Routes
- Safety Issues

Essential Planning: Site Surveys

Equipment	Equipment Room
Location	A computer equipment cabinet is situated in the office to the left of the front entrance, situated at the rear in the corner backing the warehouse complex
Rack Units available	>4
Rack/Cabinet Floor Space Available	Available
Cabinet Height	2.2m
230V Available	Yes – multi-box outlets available in cabinet
UPS Available	Unknown if 230V supply is via a UPS
-48V Available	No
-24V Available	No
Technical Earth Available	No
Air-conditioning Installed	No – general office environment with room airconditioning



Inside of roof



Roof Beam



Beam, Vertical Risers, Tray

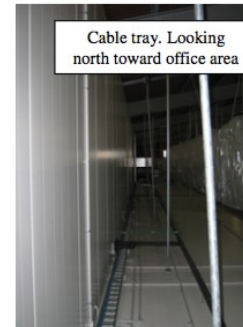


View toward northern end of roof and office area

Approximate antenna Location



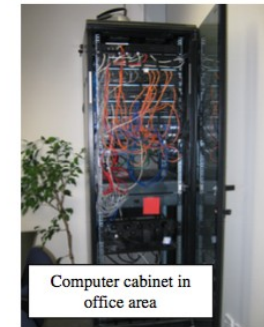
View to Cashmere Radio Tower



Cable tray. Looking north toward office area



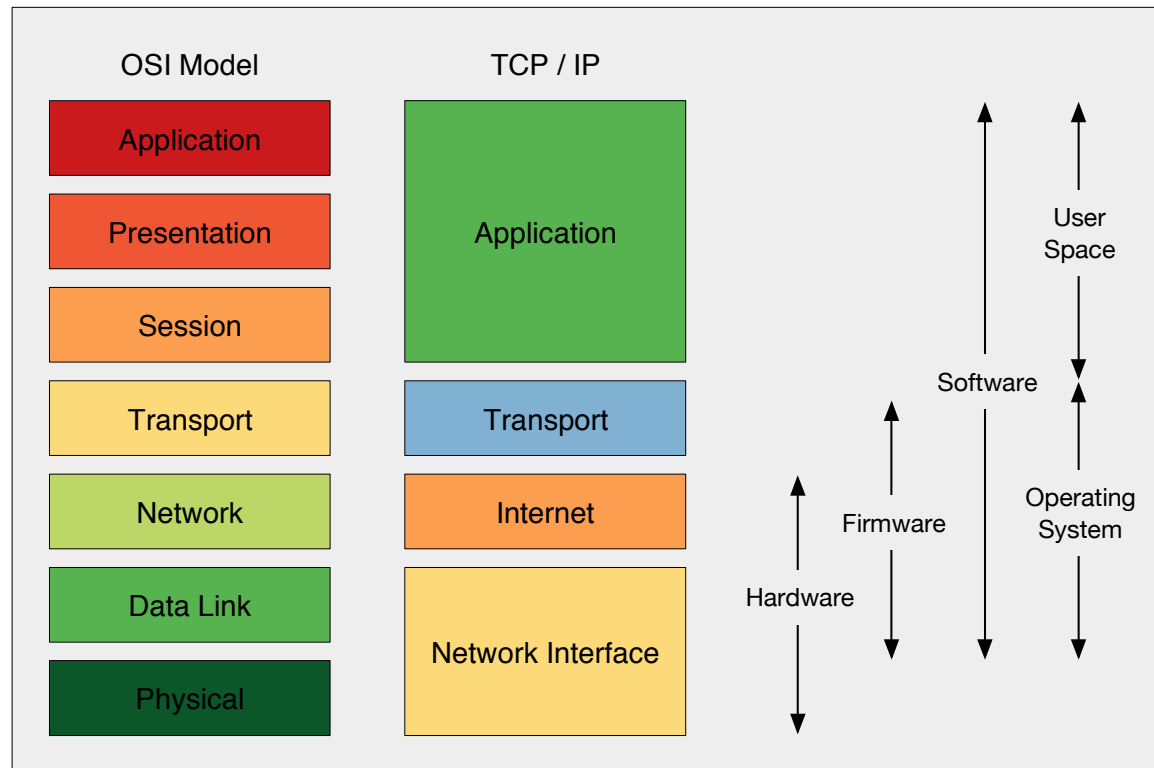
Ceiling above office area



Computer cabinet in office area

Network Layers

- | Wireless networking is more physical than wired
 - | Remember the OSI Layer you are working with!



Wireless at Layer 3

- | Wi-Fi Routers do many things
 - | Routing, NAT, Firewall, DHCP
 - | These are Layer 3 functions!
- | Keep Layer 3 functions in the wired core
 - | You cannot scale well with Wi-Fi Routers
- | An Access Point simply bridges networks
 - | This is a layer 2 function: 802.3 <-> 802.11
 - | Scalable networks use Access Points, not Routers

Wireless at Layer 2

- | Wireless Modes
 - | Master – used for Access Points
 - | Managed – for Stations (Clients)
 - | Ad-hoc – mostly used for point-to-point (though you can use Master/Station for this too!)
- | SSID (Service Set Identifier)
 - | The “Network Name”
 - | Often Human Readable

Wireless at Layer 2: SSIDs

- | SSIDs can provide user information:
 - | MyUniv-Library
 - | MyUniv-Dorm 1
 - | MyUniv-AdminWing
- | Tempting SSIDs are a bad idea
 - | Campus-Security
 - | Finance-Department
- | SSID choice can have an impact on:
 - | Roaming & network design

Roaming Considerations

- | What happens when wireless clients move:
 - | From one AP to another, in the same building?
 - | From one building to another?
 - | To a different part of campus, or a remote campus?
- | Is it important to stay on the network, without interruption (for example, to have a Voice over IP chat or video chat)?
- | Is it acceptable to log on again, when entering a new network zone?

Wireless Roaming

- | Ability to move around and stay on the network
- | Two kinds of roaming:
 - Seamless: uninterrupted, always on
 - Nomadic: interrupted, yet able to pick up again
- | Users prefer Seamless Roaming:
 - Avoids interruption
 - Avoids re-authentication
 - Keeps state and session

Basic Wireless Roaming

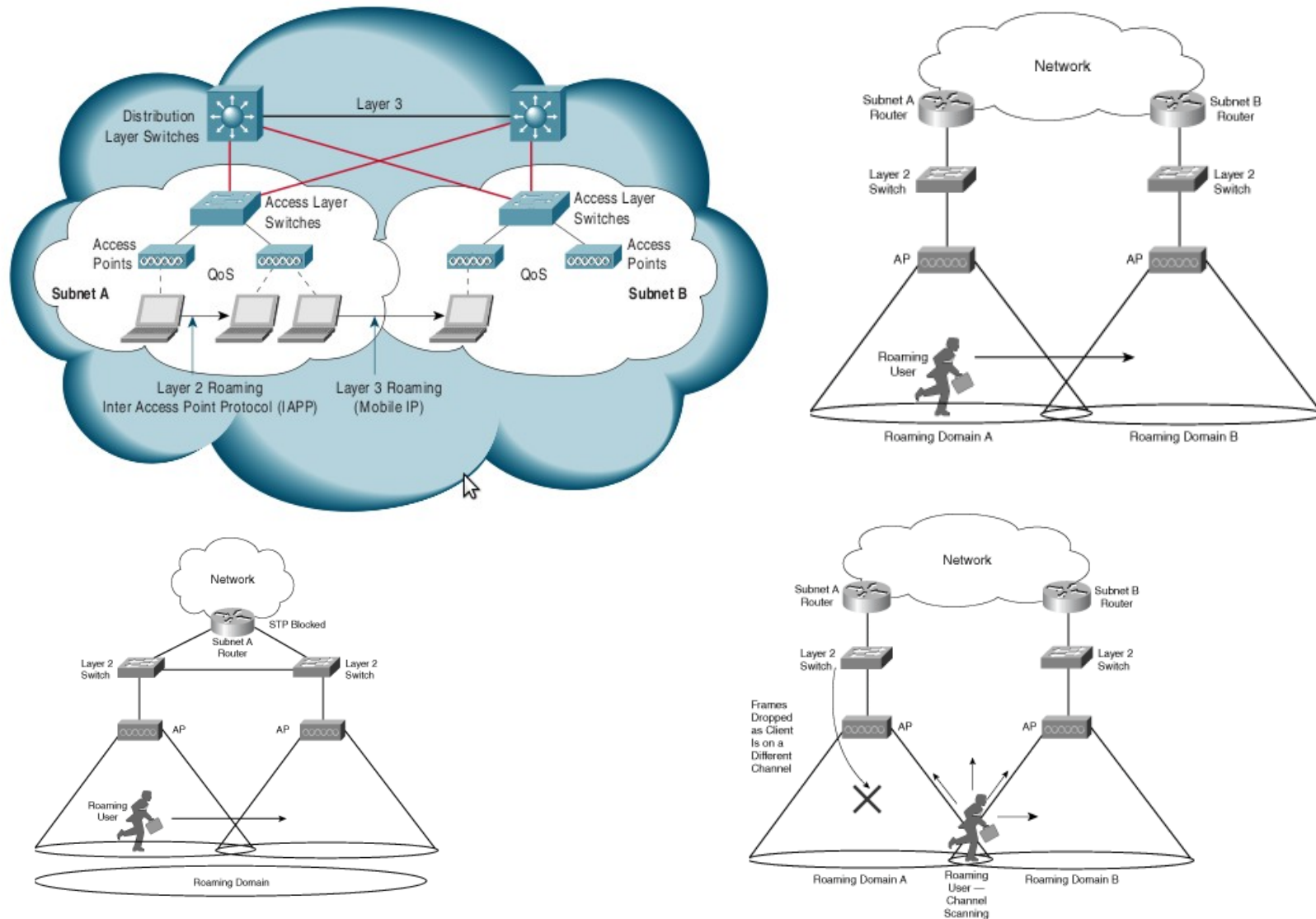
- | Roaming controls our SSID and IP design
- | The roaming domain of 802.11 is the (E)SSID
 - | clients in the same SSID can broadcast & roam
- | One SSID = (Usually) One Layer 2 Network
 - | Typically one layer 3 IP subnet
 - | Clients do not DHCP when changing APs
- | Many SSIDs = (Usually) Many Layer 2 Nets
 - | we will have interruption when roaming

Advanced Wireless Roaming

- | Enterprise Wireless Non or Pre-Standard
 - | Many new roaming standards are vendor driven
 - | Proprietary techniques can help old clients roam
 - | Controller implementations have the intelligence
- | 802.11k – devices keep lists of nearby APs
- | 802.11r – fast re-authentication on AP change
- | 802.11v – APs influence client roaming
 - | “Band Steering” is often based on 802.11v

Proprietary Roaming Techniques

Figure 2 Layer 2 and Layer 3 Roaming



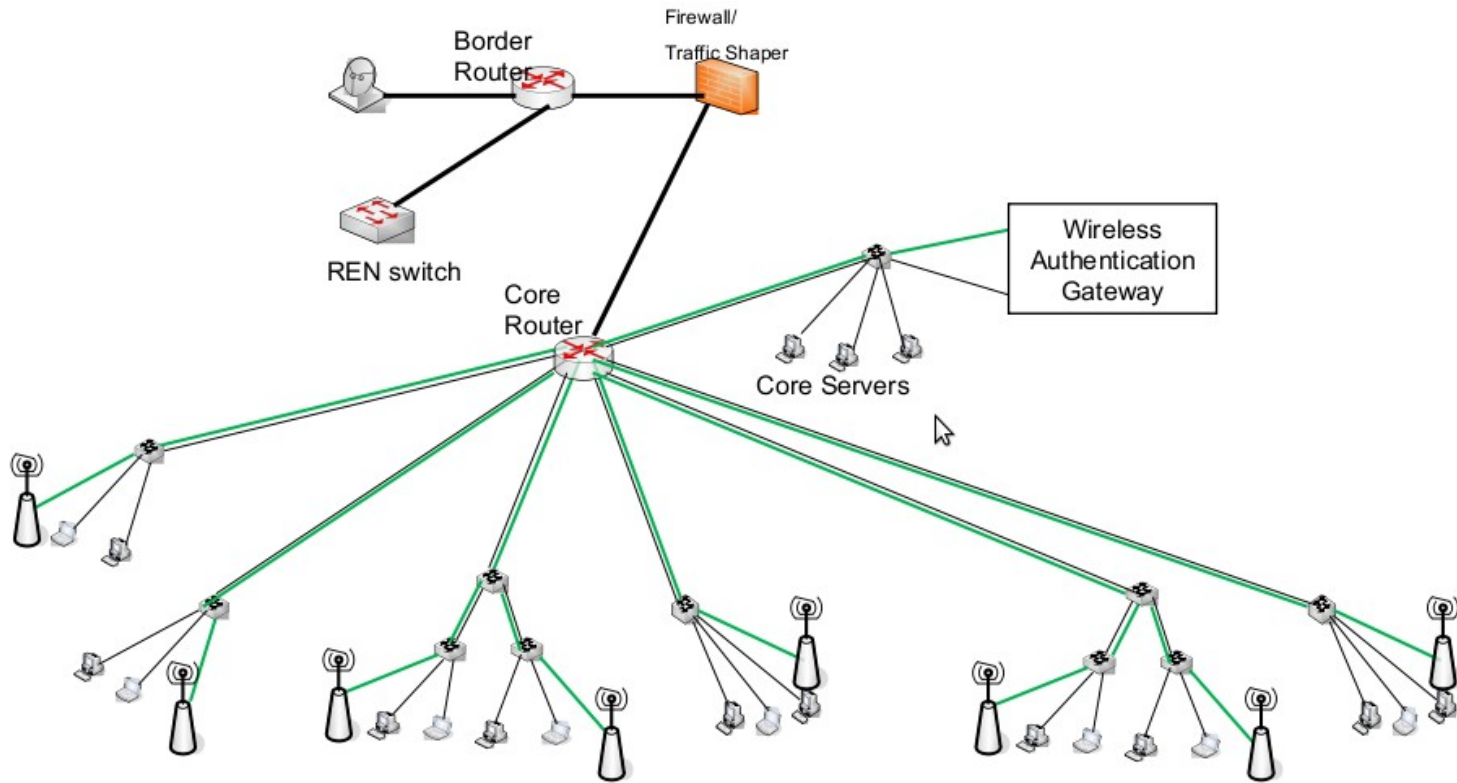
Source: Cisco

Easy Roaming

- | One SSID
 - | Roaming on Layer 2 handled by 802.11
- | One subnet
 - | Roaming on layer 3 handled by IP/DHCP design
- | Only scales so far
- | Many users = large subnet
 - 10,000 users = /18 net!
 - Broadcast traffic must be controlled

Wireless Authentication

- Keep it in the core, not on edge APs



Questions?

